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Pasture Studies with Laying Hens

University of Tennessee Agricultural Experiment Station

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PASTURE STUDIES WITH LAYING HENS

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2. SIMPLE RATIONS WITH AND WITHOUT PASTURE

By

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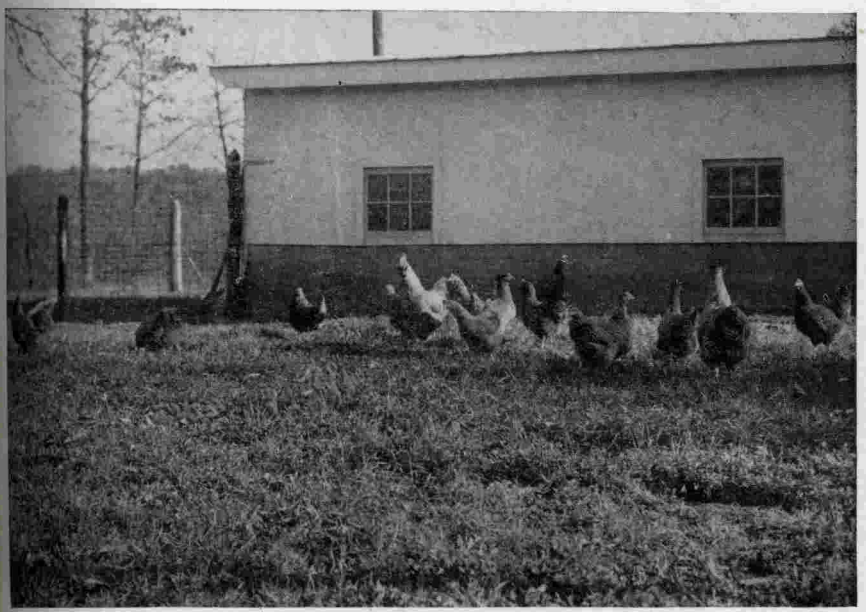

Pasture is a valuable supplement to the diet of a laying flock

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PASTURE STUDIES WITH LAYING HENS

Jesse E. Parker and B. J. McSpadden

PART 1

INFLUENCE OF WINTER PASTURES

INTRODUCTION

Recently there has been much interest in the subject of poultry pastures. Succulent green feed from grasses and legumes has come to be recognized as highly nutritious for poultry. Lack of it in the diet must be compensated for by expensive feed supplements. With the existing shortages of dried-milk products, meat meals, and high-grade alfalfa meals, pastures are playing an increasingly important role in poultry nutrition as a source of vitamin A, riboflavin (vitamin G), minerals, and even protein.

During the spring and summer months, most farm chickens in Tennessee have access to green feed from permanent pastures, but in the late fall and winter months little succulent green feed is available. Since the climate in most parts of the State is well suited to the production of certain winter pasture crops, it was believed that investigations on winter pastures for laying hens would be of considerable interest to Tennessee poultry raisers.

REVIEW OF LITERATURE

On the basis of extensive investigations at the Ohio Experiment Station, Kennard and Chamberlin (1934) concluded that egg production of layers on range exceeds that of layers confined and fed a complete ration. They observed little difference in mortality rate between birds confined and those on range, but found lower egg production and higher mortality rates in layers maintained on a bare yard.

Berry (1932) reported that hens having access to alfalfa range produced eggs at a lower feed cost per dozen and had a lower mortality rate than hens maintained on bare yards and fed 10 percent alfalfa meal or alfalfa leaf meal in the laying mash. He observed, however, that during the winter months alfalfa range had an undesirable effect on egg yolk color. In a later publication, Berry (1938) concluded, after several years' studies with various types of green feed, that alfalfa was superior to cereal grasses as a year-round pasture crop for laying hens. Returns were largest when the flock was restricted to two hours of grazing per day.

Results of recent experiments conducted at the Mississippi Station by Sipe and Polk (1941) showed that pasture reduced the feed requirements for egg production from 5.7 to 10.1 percent. Less mortality occurred in the lots

with grazing. Size and hatchability of eggs were not influenced by green feed, but yolk color of eggs produced by birds on grazing crops was darker than that of eggs from birds on a dry lot. Of three crops studied, ryegrass provided the largest number of grazing days; oats the second largest, and mustard third. Ryegrass and oats were superior to mustard for winter pasture.

Gish and Payne (1940) demonstrated that pullets fed immature cereal grasses, either fresh or ensiled, gave larger returns per bird and had about as satisfactory livability, hatchability, and egg size as pullets fed "Greenmelk" or dehydrated alfalfa leaf meal.

Results of studies by Ringrose and Morgan (1939) on the effect of green feed upon the interior quality of fresh eggs showed that this supplement did not affect the quality of eggs, as determined by height of firm albumen, percentage of firm albumen, or yolk index.

EXPERIMENTAL PROCEDURE

During the interval from October 23, 1940, to May 6, 1941, five lots of 41 Barred Rock pullets each were maintained under different conditions of pasture and management, to determine the best system for obtaining the most efficient performance from laying pullets during the winter months. The pullets were from unselected breeding, and were hatched March 13, 1941. Each group was housed in 10′ x 18′ sections of similar laying houses. The size of yards available to three of the lots (A-1, A-2, and A-3) was 40′ x 75′. Lot A-4 was maintained inside the laying house during the entire 28-week period. Pullets in lot A-5 had access to several acres of permanent range. This pasture was a mixture of grasses and weeds; but during the period of these studies Kentucky bluegrass provided practically all of the green feed.

Laying mash and grain were before the birds in hoppers at all times. Lots A-1, A-2, A-3, and A-5 received the same kind of laying mash, which had the following composition and will be referred to as the "basal" mash:

Ground yellow corn	30 pounds
Wheat red dog flour	25 pounds
Wheat bran	25 pounds
Meat meal (55% protein)	20 pounds
Salt	1 pound

Lot A-4, the confined pen, received a mash of the following composition, which will be referred to as the "supplemented" mash:

Ground yellow corn	25 pounds
Alfalfa leaf meal	5 pounds
Wheat red dog flour	25 pounds
Wheat bran	25 pounds
Meat meal (55% protein)	15 pounds
Dried skimmilk	5 pounds
Salt	1 pound
Cod-liver-oil concentrate	250 grams

The grain, or scratch feed, supplied to all lots was composed of 70 pounds of whole yellow corn and 30 pounds of oats. In addition, oyster shell was available in the pens at all times. Table 1 shows the kind of pasture and the type of management that each of the five lots of pullets received.

TABLE 1—*Systems of management used on five lots of Barred Plymouth Rock pullets.*

Lot	Pasture	Permitted outside range	Rations fed	
			Mash	Grain
A-1	None—bare lot	Afternoons	Basal	All lots received a mixture of 70 pounds yellow corn and 30 pounds oats.
A-2	Ryegrass and crimson clover[1]	Afternoons	Basal	
A-3	Winter oats[2]	Afternoons	Basal	
A-4	None	None—confined	Supplemented	
A-5	Permanent	All day	Basal	

[1]The mixture of ryegrass and crimson clover was sown August 24.
[2]Winter oats were sown September 30.

In order that data might be obtained on hatchability of eggs, three cockerels were kept in each of the five pens from October 23 until eggs no longer were saved for hatching purposes. In adjusting for the feed consumed by the males, it was assumed that the males and females used the same quantities.

Body weights were determined in the mornings, when the pullets were empty. Eggs from the five lots were placed in the incubator on four dates, from January 13 to March 22. Percentage hatchability was determined from the number of fertile eggs that hatched. Data on egg weights were obtained by the weighing of all eggs laid on four successive days each month from January to April, inclusive. Each 4-day period was near the middle of the month.

The influence of the different conditions of management on egg quality was found by examination of all eggs produced on April 28 and May 6 for certain egg-quality factors. Albumen quality was measured by two methods, as follows:

1. Percent of thick albumen.—The total weight of the albumen was determined. The thin, or watery, albumen was removed by means of a 50-cc. pipette with a 1-mm. opening. The percent of thick albumen was calculated by division of the weight of the remaining portion by the total weight of the albumen.

2. Albumen score.—The broken-out condition of the albumen was noted according to the code of Heiman and Carver (1936). Eggs that were observed to have a large percent of upstanding albumen were given a score of 1. Those that appeared to have very little or no thick albumen were scored 5. Scores of 2, 3, and 4 were given to intermediate grades.

Color of egg yolk was determined by comparison with the yolk-color rotor described by Heiman and Carver (1935).

With the exception of lot A-5, the experiments were repeated during the interval from October 30, 1941, to May 13, 1942. In the second 28-week trial, 35 Barred Rock pullets were used in each lot instead of 41. For this trial the oats were seeded in lot A-3 on September 20. It was not necessary

to seed lot A-2 with the ryegrass-crimson clover mixture in the fall of 1941, as there was a good stand resulting from the crops' reseeding themselves the previous year. No data were recorded on hatchability and interior quality of eggs during the second trial.

In both trials all pullets in the experiments were trapnested. Artificial lighting was not used.

RESULTS

OBSERVATIONS ON PASTURES

During the 1940-41 experiments, both winter oats and the ryegrass-crimson clover mixture provided green feed throughout the 28 weeks of the investigations (figs. 1 and 2). An adequate supply of green feed was supplied throughout the second trial by the ryegrass-crimson clover pasture and until the latter part of February by the winter oats pasture. The very cold weather prevailing in February 1942 caused considerable damage to the oats pasture. This winterkilling probably was aggravated by the fact that the oats had made considerable growth prior to the onset of cold weather. This lot was reseeded with spring oats on March 19, and adequate grazing again was available during the last month of the investigations.

Observations of the pullets' grazing indicate that Kentucky bluegrass, winter oats, and the ryegrass-crimson clover plants are palatable to chickens. Under the conditions of these investigations, the ryegrass-crimson clover pasture appeared to be more resistant to grazing than winter oats, as a larger portion of the latter pasture around the house was killed by overgrazing.

Fig. 1—Ryegrass-crimson clover pasture

EGG PRODUCTION

Egg-production data for the five lots are shown in table 2. Percentage of egg production for the pullets with the bare yard (lot A-1) was low for both trials. Production in lots A-2, A-3, and A-5 was about the same. In the 1940-41 trial, egg production in the pen that was confined and fed the supplemented mash (lot A-4) was similar to that of lot A-1, but in the 1941-42 trial this pen had the highest production of all lots. No positive explanation for this difference can be given. Very little was known about the parentage of the pullets used in these experiments, and it is conceivable that the performance of lot A-4 during the two trials was influenced by unequal distribution of pullets with regard to egg-production capacity. Such dis-

TABLE 2—*Influence of winter pastures on egg production of Barred Rock pullets.*

Lot	Pasture	Egg Production[1]		
		1940-41	1941-42	Average[2]
		Percent	Percent	Percent
A-1	None—bare yard	31.1	29.4	30.4
A-2	Ryegrass and crimson clover	41.0	33.6	37.8
A-3	Winter oats	41.2	38.8	40.2
A-4	Confined—supplemented mash[3]	31.0	41.1	35.4
A-5	Permanent pasture	41.1	.....	[4] 41.1

[1]Percentage of egg production calculated on a bird-day basis to eliminate the influence of mortality.

[2]Weighted average.

[3]Mash supplemented with 5% alfalfa leaf meal, 5% dried skimmilk, and 0.5% cod-liver-oil concentrate (Nopco XX).

[4]One trial only, 1940-41.

Fig. 2—Winter oats pasture

crepancies are not uncommon in experiments of this type when relatively small numbers of birds are used and they are not allotted to groups on a family basis. The average production for the two years, of course, would be more representative than the performance in either trial considered separately. On the basis of the 2-year performance of all groups, it is apparent that pullets with access to green feed laid better than pullets without green feed, and that a supplementary feeding of alfalfa leaf meal, dried milk, and cod-liver oil will serve, at least partially, as a substitute for pasture.

FEED CONSUMPTION

Providing the layers with green feed did not reduce the total amount of feed consumed per bird (table 3). In fact, the three lots of pullets with pasture consumed more feed per individual than the pullets on the bare yard. Although the pullets with pasture consumed more feed, they utilized their feed more efficiently than those without pasture (table 3). Approximately 2 pounds less feed was required to produce a dozen eggs in lot A-3 (oats pasture) than in lot A-1 (bare yard). Feed utilization of the pullets confined and fed the supplemented mash was somewhat more efficient than that of the bare-yard group, but less so than that of the groups with pasture. By providing winter pasture, farmers will not necessarily reduce their feed bills, but they should increase the income from their laying flocks.

TABLE 3—*Influence of winter pastures on feed consumption and efficiency of feed utilization of Barred Rock pullets.*

Combined data for two 28-week trials

Lot	Pasture	Feed consumed per pullet			Feed required per dozen eggs
		Grain	Mash	Total	
		Pounds	Pounds	Pounds	Pounds
A-1	None—bare yard	31.4	15.6	47.0	9.5
A-2	Ryegrass and crimson clover	35.9	16.2	52.1	8.5
A-3	Winter oats	34.8	15.2	50.0	7.6
A-4	Confined—supplemented mash	34.9	16.4	51.3	8.9
A-5	Permanent pasture	[1] 32.6	[1] 20.3	[1] 52.9	[1] 7.9

[1]Data for 1940-41 trial only.

HEALTH OF LAYERS

The general health of a laying flock is difficult to measure. Perhaps the most reliable criterions of this condition are percentage of egg production,

TABLE 4—*Weight changes, mortality, and hatchability in five lots of Barred Rock pullets.*

Combined data for two 28-week trials

Lot	Pasture	Initial body weight	Increase in body weight	Mortality	Incubation data[1]	
					Fertile eggs set	Hatchability
		Pounds	Pounds	Percent	Number	Percent
A-1	None—bare yard	6.0	0.12	26.3	345	50.1
A-2	Ryegrass and crimson clover	5.9	0.48	25.0	440	77.1
A-3	Winter oats	5.8	0.14	24.0	458	78.2
A-4	Confined—supplemented mash	5.7	0.52	27.6	233	77.3
A-5	Permanent pasture	[2] 5.8	[2] 0.36	[2] 29.3	476	77.7

[1]Data for hatchability are weighted averages for 4 hatches, ranging from January 13 to March 22, 1941.

[2]Data for 1940-41 trial only.

changes in body weight, and mortality. Data on weight changes and mortality in the several lots of pullets are presented in table 4. All groups gained in average body weights, although the gains made by lots A-1 and A-3 were relatively small.

Percentage mortality was high in all lots, but since most of the losses were due to diseases of the leukosis complex, it cannot be concluded that the differences in management influenced mortality rate.

HATCHABILITY

Numerous experiments conducted by various investigators have revealed the fact that the ability of the fertilized egg to hatch into a vigorous chick is influenced materially by the diet fed the mother hen. This applies to certain minerals, proteins, and vitamins (particularly G). Since green plants supply an abundance of vitamin G, as well as other nutrients, they are beneficial to breeding flocks. The results on hatchability from these experiments (table 4) further demonstrate the value of green feed for breeders. Hatchability was increased more than 50 percent when winter pasture was provided or the diet of confined pullets was reinforced with alfalfa leaf meal, dried skimmilk, and cod-liver oil.

EGG SIZE AND QUALITY

Egg size in all lots (table 5) was satisfactory, as eggs produced by each group averaged above 24 ounces per dozen (or 57 grams per egg), which is the standard. Since not many eggs were examined for interior quality, the small differences probably are not significant. The results indicate, however, that so far as quality of albumen is concerned, laying birds with access to pastures produce eggs as desirable as those produced by confined birds. This is somewhat contrary to popular belief, but is in accord with the recent report of Ringrose and Morgan (1939).

TABLE 5—*Weight and interior quality of eggs from Barred Rock pullets as related to winter pasture.*

Lot	Pasture	Egg size		Interior quality of eggs				
		Eggs weighed	Average weight	Eggs examined	Thick albumen		Yolk color (color rotor reading)	
		Number	Grams	Number	Percent	Index	Range	Average
A-1	None—bare yard	386	59.1	30	46.2	2.0	11-17	14.9
A-2	Ryegrass and crimson clover	482	59.6	34	45.0	2.1	15-17	16.3
A-3	Winter oats	527	58.2	42	42.6	2.4	16-17	16.1
A-4	Confined—supplemented mash	454	57.7	36	41.5	2.5	13-16	15.2
A-5	Permanent pasture	275	58.5	40	43.7	2.1	15-17	16.3

Results from observations on egg yolk color are also presented in table 5. The mean yolk color of eggs produced by each of the three pens on pastures (lots A-2, A-3, and A-5) was about the same. The averages for the two other groups were approximately one shade lighter in color. When the ranges in yolk color are considered it is observed that egg yolks from lots on

pastures were more uniform, varying from one to two shades in each pen, whereas those from the two non-pasture lots (A-1 and A-4) showed considerably more variation. From the consumer's viewpoint, uniformity of yolk color is probably more desirable than the average yolk color. The wide variations in yolk color from lots A-1 and A-4 could conceivably be explained on the ground that individual differences in ratios of grain and mash consumption existed in these lots. Also some hens may have consumed larger amounts of yellow corn from the corn-wheat-oats mixtures than others. In the pens with access to pasture, the consumption of green feed tends to reduce the effect of these individual feed preferences on yolk color.

SUMMARY

Restricted[1] winter grazing of winter oats or a mixture of ryegrass and crimson clover, and unrestricted grazing on permanent pasture increased winter egg production 25 to 35 percent over the production of pullets with access to a bare lot. The addition of 5 percent alfalfa leaf meal, 5 percent dried skimmilk, and .5 percent cod-liver-oil concentrate to the mash of confined pullets increased their average egg production approximately 16 percent over that of pullets receiving no green feed or green feed substitute.

Hatchability was good in the three pens with pasture and in the pen that received the supplemented laying mash. The hatchability in each of these pens was over 75 percent, whereas the hatchability from the bare-yard group was 50 percent.

Neither restricted nor unrestricted grazing was observed to influence egg quality adversely. More uniformity in yolk color was observed in the pasture groups than in the non-pasture groups.

In view of the findings in these investigations it is apparent that good pastures for laying hens are an economical source of certain required nutrients for the laying flock.

[1]Afternoons only.

PART 2

SIMPLE RATIONS WITH AND WITHOUT PASTURE

INTRODUCTION

Many farm poultry raisers produce a quantity of grains which, if supplemented with some source of animal protein, minerals, and possibly certain of the necessary vitamins, should provide a balanced diet for their laying flocks. Some of these flocks, because they are improperly fed, are not producing eggs economically. Any system of feeding that utilizes farm-grown feeds to the greatest extent should be welcomed by farmers at any time, and particularly during the present emergency. With these facts before it, the Tennessee Agricultural Experiment Station started investigations in 1941 to determine the efficiency of simple rations when fed to laying pullets with and without pasture. The value of winter pasture as a supplement to the diet of laying hens is pointed out in Part 1 of this bulletin.

REVIEW OF LITERATURE

With regard to the feeding of simple rations to laying hens, Cassel (1927) stated, "A ration to be complete must contain all the essentials such as protein of the proper quality, carbohydrates, fats, mineral, and vitamins. In order to meet these essentials in poultry feeding various complicated feed formulae have been advised with various feeding practices and systems of management. The result has been that many farmers and poultry keepers have become discouraged and bewildered due to high prices and difficulty in securing the various recommended ingredients. It has meant that many farmers and poultrymen have been purchasing expensively prepared feeds, when they have been in a position to compound excellent rations, using the home grown grains, if they fully appreciated and understood the value of the various feeds available on the farm." On the basis of experimental results, Cassel concluded that pullets fed a ration consisting of either whole grains or ground grains, skimmilk and fresh-cut green feed performed as well as pullets fed a standard laying ration which included laying mash, scratch grains, green feed, and skimmilk. Martin (1925) found that laying hens fed a ration of skimmilk and whole grains performed as well as those fed a laying mash and grain diet. Both groups had the run of yards well set in bluegrass sod.

It is a rather common assumption among poultrymen that chickens do not have the capacity for taking care of their nutritional requirements when given a number of feedstuffs free choice. This is shown by results with White Leghorn pullets, published by Tomhave and Mumford (1931). In their experiments hens with access to 21 different feedstuffs did not lay as well as a pen on an all-mash ration. They concluded, "When hens are permitted to select the ingredients of their ration, they will not select the ingredients in the proper proportions for efficient production."

More recent reports by Graham (1934), Davidson (1939), Robertson, Carver, and Cook (1939), and Callenbach and Murphy (1942) show that

laying hens can balance their rations when given free access to grains and various types of laying mashes. Graham observed that when pullets in batteries were fed mash, corn, and oats free-choice they balanced their crude protein intake fairly constantly day by day. Some laid well and gained in weight on a protein level of 12 to 13 percent, while others wanted or required 14 to 15 percent. Davidson compared groups fed 18-percent and 30-percent mashes, both being allowed continued access to grain mixtures. In his experiments, conducted with both White Leghorns and Rhode Island Reds, differences between pens on the 18- and 30-percent mashes were small. Robertson, Carver, and Cook observed that pullets fed free choice a 41-percent protein supplement, cracked corn, whole oats, and wheat laid considerably better than pullets on an all-mash diet and slightly better than those on mash-grain rations.

DESCRIPTION OF EXPERIMENT

In the present studies two experiments were conducted, each with 6 lots of Rhode Island Red pullets. In the first experiment 25 pullets per lot were housed on November 1, 1941; and in the second, 24 pullets per lot were housed on November 4, 1942. In each experiment the pullets were housed in similar 7′ x 20′ sections of a laying house. Four of the lots—C-2, C-3, C-4, and C-5—had access to yards 40′ x 80′, which provided adequate pasture for afternoon

TABLE 6—*Rations and pasture for six lots of Rhode Island Red pullets.*

Lot	Grain	Supplement	Yard
C-1	Grain mixture Yellow corn[1] 50 lbs. Heavy oats 25 lbs. Wheat 25 lbs.	Meat meal	Bare—20′ x 20′
C-2	Grain mixture same as C-1	Meat meal	Pasture[3]—40′ x 80′
C-3	Yellow corn[1]	Skimmilk[2], 1 gal. per day	Pasture—40′ x 80′
C-4	Yellow corn	Meat meal	Pasture—40′ x 80′
C-5	Yellow corn	Mash 30 lbs. yellow corn meal 25 lbs. red dog flour[4] 25 lbs. wheat bran 20 lbs. meat meal 1 lb. salt	Pasture—40′ x 80′
C-6	Yellow corn	Mash, same as for lot 5 except 5 lbs. alfalfa meal substituted for 5 lbs. corn meal.	Bare—20′ x 20′

Oyster shell was available to all lots.

[1]Although yellow corn is generally preferred to white corn as a poultry feed because of its greater vitamin-A content, the white variety is more readily available on many Tennessee farms. White corn should prove satisfactory in the diet if the poultry raiser is cognizant of its vitamin deficiency and supplies some adequate source of vitamin A, such as good pasture.

[2]On some days during the first part of the experiment the pullets in lot C-3 failed to consume all of their daily allowance of milk (1 gallon). On such occasions the remaining milk was measured back. During the latter half of the experiment, when the pullets were laying at a more rapid rate, water was supplied after they consumed their daily allowance of 1 gallon of skimmilk.

[3]Crimson clover and winter oats pasture available for lots C-2, C-3, C-4, and C-5. Hens were permitted to graze in afternoons.

[4]During the 1942-43 trial, ground wheat was substituted for red dog flour because the latter was not available.

grazing, except during very cold weather. A mixture of crimson clover and Tennex winter oats was used both years for pasture crops in the four pasture lots. The pasture crops were sown on September 20, 1941, and September 27, 1942. Approximate rates of seeding per acre were: oats, 4 bushels; crimson clover, ½ bushel. Lots C-1 and C-6 also were turned outside in the afternoons, but on small 20′ x 20′ bare yards. The rations for the six groups, which were fed free-choice in hoppers, are shown in table 6.

Although the pullets were placed under the experimental conditions during the first week in November, the collection of data included herein was not commenced until 4 weeks later. It was thought advisable to allow this preliminary period for the pullets to become accustomed to the experimental rations, and also because a number of the pullets, which were hatched late in the season, were not in production. An attempt was made to have pullets of comparable ages and breeding in the six groups. All layers were trapnested. Artificial lighting was not used.

Feed costs were based upon the prices paid by the Tennessee Experiment Station during the course of these investigations. The average prices are shown in table 7. Skimmilk consumed by lot C-3 was obtained from the University Creamery. A charge of 3 cents per gallon was made for this milk.

TABLE 7—*Average prices paid by the Tennessee Experiment Station for feedstuffs.*

Feed	Average cost per 100 pounds	
	1941-42	1942-43
Yellow corn	$1.89	$2.36
Wheat	2.10	2.10
Oats	2.34	2.50
Meat meal	3.40	3.40
Wheat red dog flour	2.25	.....
Ground wheat	.....	2.15
Wheat bran	2.16	2.32
Yellow corn meal	2.12	2.49
Alfalfa leaf meal	2.11	2.75
Salt	1.00	1.05

Data on body weight, egg weight, and egg quality[2] were obtained by methods described in Part 1 (see page 5). Percentages of hatchability were based upon the number of fertile eggs that hatched. Eggs were placed in the incubator on March 18 and May 10, 1942, and on April 14, 1943. Barred Rock males were rotated between the pens to fertilize eggs for the first hatch; for the other two hatches, fertile eggs were obtained by artificial insemination of the pullets with mixed semen from several Rhode Island Red males. Artificial insemination is particularly well adapted to experiments of this nature. It makes possible the securing of incubation data; and at the same time more accurate feed records can be kept, since feed consumed by males does not have to be considered.

RESULTS

EGG PRODUCTION

Egg-production data for each trial and averages of both trials are presented in table 8. Comparison of lot C-1 with lot C-2 demonstrates the value

[2]Eggs used for the studies of interior egg quality were collected from April 15 to 18, 1942, and from April 26 to 29, 1943. Observations were made the day following laying.

of winter pasture for increasing winter egg production. In the two trials the pasture group layed 24 percent more eggs than the no-pasture group. These data confirm the results obtained with Barred Rock pullets (table 2).

There was very little difference in rate of laying for lots C-2, C-3, and C-4. It is surprising that pullets fed on such simple rations would perform so well. Although not quite as high, the percentages of production from the three groups compare favorably with those obtained from the pen fed laying mash, corn, and pasture (lot C-5), and are about the same as those of the pen fed laying mash, supplemented with alfalfa leaf meal, grain, and pasture (lot C-6). The fact that egg production of lot C-5 is slightly higher than that of lot C-6 indicates that 5 percent of alfalfa leaf meal added to the laying mash is not a complete substitute for green feed from pasture.

The egg production of the hens in lot C-3 demonstrates that on farms where skimmilk is available at the rate of 4 gallons per day per 100 hens, reasonably good egg production can be obtained if farm-grown grains are fed and good pasture is provided.

TABLE 8—*Percentages of egg production in six lots of Rhode Island Red pullets fed simple rations with and without pasture.*

Lot	Ration	Egg Production[1]		
		1941-42	1942-43	Average[2]
		Percent	Percent	Percent
C-1	Mixed grains, meat meal, no pasture	25.2	61.6	42.7
C-2	Mixed grains, meat meal, pasture	40.3	66.8	53.0
C-3	Yellow corn, skimmilk, pasture	40.6	66.1	53.2
C-4	Yellow corn, meat meal, pasture	41.5	68.2	54.1
C-5	Yellow corn, mash, pasture	45.7	73.4	58.8
C-6	Yellow corn, mash with 5% alfalfa leaf meal, no pasture	37.2	72.7	54.5

[1]Percentages of egg production calculated on a bird-day basis to eliminate the influence of mortality.

[2]Weighted average.

The relatively high egg production in the second trial as compared with that in the first, probably was influenced by two factors. In the first experiment a slight outbreak of fowl pox was observed in all lots. While there were no deaths from the disease, there was a temporary falling off in egg production. The other and probably more important factor was breeding; a larger percentage of the pullets used in the 1942-43 trials were from high-producing families.

FEED CONSUMPTION

Pullets with access to pasture consumed a little more feed than those without pasture, but the feed cost per dozen eggs was considerably less (see results for lots C-1 and C-2 in table 9). This is in accord with results obtained on Barred Rock pullets with respect to the effect of pasture on feed consumption (table 3). The lowest feed consumption per pullet was obtained with the skimmilk-corn-pasture diet. On the basis of prices paid by the Experiment Station for feedstuffs, the hens provided with laying mash, corn, and pasture (lot C-5) produced eggs the most economically because the egg production of this group was somewhat higher than that of the other groups.

It is observed, however, that approximately half of the diet of this lot was laying mash. Had the grains consumed by lots C-3, C-4, and C-5 been figured

TABLE 9—*Feed consumption and feed cost per dozen eggs.*
Combined data for two 24-week trials

Lot	Ration	Feed consumed per pullet			Feed cost per dozen eggs		Estimated crude protein in ration[1]
		Grain	Supplement	Total			
		Pounds	Pounds	Pounds	Pounds	Cents	Percent
C-1	Mixed grains, meat meal, no pasture	36.4	6.1	42.5	7.1	16.9	16.6
C-2	Mixed grains, meat meal, pasture	37.6	6.2	43.8	5.9	14.0	16.6
C-3	Yellow corn, skimmilk, pasture	34.9	[2] 5.5	40.4	5.4	12.8	12.8
C-4	Yellow corn, meat meal, pasture	32.7	8.3	41.0	5.4	12.9	18.1
C-5	Yellow corn, mash, pasture	22.9	21.0	43.9	5.3	12.2	14.7
C-6	Yellow corn, mash with 5% alfalfa leaf meal, no pasture	24.8	21.3	46.1	6.1	13.8	14.8

[1]Percentages of crude protein calculated on basis of data on average composition of feedstuffs, U.S.D.A. yearbook, 1939, pp. 839-843.
[2]Pounds of dried skimmilk equivalent to amount of liquid skimmilk consumed per pullet.

at farm prices it is probable that there would have been a still smaller difference in the cost per dozen eggs. On some farms it may be economical to feed the simpler rations, provided good pasture and some source of animal protein are available.

A comparison of results with lot C-5 and lot C-6 indicates that when hens are laying at comparable rates, less feed is required per bird and per dozen eggs if the hens have access to grazing.

The percentage of crude protein in the corn-skimmilk ration was considerably lower than that in any of the other rations; and that in the corn-meat meal ration was the highest. These and the data on this point for the other lots (table 9) indicate that the sources of proteins, as well as amounts of crude proteins, are both important factors in poultry nutrition. The proteins in milk products have been recognized as having high biological values. Martin (1925) found that laying hens fed milk and whole grains consumed less feed, with a wider nutritive ratio, than those receiving mash in the ration.

WEIGHT CHANGES, MORTALITY, AND HATCHABILITY

A satisfactory laying ration should supply enough essential nutrients to produce eggs and maintain body weight. Pullets in all pens made significant

TABLE 10—*Weight changes, mortality, and hatchability in six lots of Rhode Island Red pullets fed simple rations with and without pasture.*
Combined data for two 24-week trials

Lot	Ration	Initial body weight	Increase in body weight	Mortality	Fertile eggs set	Hatchability of fertile eggs
		Pounds	Pounds	Percent	Number	Percent
C-1	Mixed grains, meat meal, no pasture	5.0	0.65	12.2	246	72.4
C-2	Mixed grains, meat meal, pasture	5.1	0.80	2.0	317	82.6
C-3	Yellow corn, skimmilk, pasture	5.1	0.42	8.2	316	78.2
C-4	Yellow corn, meat meal, pasture	5.1	0.59	4.1	278	80.2
C-5	Yellow corn, mash, pasture	5.0	0.46	2.0	297	80.8
C-6	Yellow corn, mash with 5% alfalfa leaf meal, no pasture	5.0	0.59	12.2	309	82.2

gains during the 28 weeks they were on the experiment (table 10). Percentages of mortality were relatively low in all pens. Pullets fed the simple rations lived as well as those fed the laying mash and grain rations.

Eggs produced in all lots hatched well (table 10). The results of hatchability studies on lots C-1 and C-2 show that green feed has a beneficial influence. These results agree with those on the relation of green feed to hatchability obtained with Barred Rock pullets (table 4).

WEIGHT AND INTERIOR QUALITY OF EGGS

Egg size in all lots was satisfactory; weights averaged from 3.5 to 5.1 grams over the standard egg weight of 57 grams (table 11). The largest eggs were produced by the skimmilk-fed pen. This observation is in agreement with results obtained by other workers, which show that the feeding of milk increases egg size.

Interior egg quality, as measured by the percentage of thick albumen and the albumen index, was as good in the lots fed the simple rations as in those

TABLE 11—*Egg size and interior quality of eggs produced by six lots of Rhode Island Red pullets fed simple rations with and without pasture.*

Combined data for two 24-week trials

Lot	Ration	Egg size		Interior quality of eggs				
		Eggs weighed	Average weight	Eggs examined	Thick albumen		Yolk color (color-rotor reading)	
		Number	Grams	Number	Percent	Index	Range	Average
C-1	Mixed grains, meat meal, no pasture	351	60.7	50	51.1	2.4	7-16	12.5
C-2	Mixed grains, meat meal, pasture	437	61.1	50	53.2	2.6	13-17	15.9
C-3	Yellow corn, skimmilk, pasture	421	62.1	50	55.8	2.5	16-17	16.9
C-4	Yellow corn, meat meal, pasture	414	60.7	50	55.0	2.4	16-17	16.8
C-5	Yellow corn, mash, pasture	478	60.6	50	53.0	2.3	13-17	16.2
C-6	Yellow corn, mash with 5% alfalfa leaf meal, no pasture	434	60.5	50	54.1	2.3	13-16	15.4

fed the laying mash and grain ration (table 11). The results also show that in albumen quality the eggs from lots having access to pasture compared favorably with those from the no-pasture lots.

Data relative to yolk color reveal the fact that the average color indexes in the four pasture lots were higher (darker in color) than in the two lots without pasture. The least variation in yolk color, however, was observed in lots C-3 and C-4. The great amount of yolk-color variation that occurred in lot C-1 probably was due to the individual preferences of the birds for certain grains in the mixture of scratch grains. Yellow corn contains much yellow pigment, whereas oats and wheat contain very little. Lot C-2 received a similar ration to that of C-1, but since C-2 had pasture, very light-colored yolks were not produced, and consequently the range in yolk colors was not as wide. Yolk colors 16 and 17 are rich orange. On some markets they might be considered too dark; but uniformity in yolk color is more desirable

from the consumer's viewpoint than any particular degree of coloring, so long as the color is not unusually dark. In general, the darker-colored yolks contain more vitamins than the lighter-colored, and for that reason the popularity of the orange-colored yolks will increase as consumer education advances.

FEATHER PICKING

If feather picking occurred in any of the lots during the 1941-42 experiment, it was too slight to be noticed. During the 1942-43 experiments, however, the condition was so severe in some pens as to make the birds very unattractive, although no mortality resulted from it. The loss of feathers apparently did not interfere with egg production, as all pens performed much better than during the previous year. On March 24, 1943, all pullets were observed, and an arbitrary method of scoring the degree of feather loss was employed. Birds with no noticeable loss of feathers were scored 0, and those with the greatest loss were scored 3. Intermediate degrees of depluming were scored 1 and 2. To score 3, a bird had to show considerable feather loss in the three or four areas affected—back, abdomen, neck, and tail. The results of these examinations are shown in table 12.

TABLE 12—*Feather picking in six lots of Rhode Island Red pullets,* 1942-43. Data obtained March 24, 1943

Lot	Ration	Pullets showing varying degrees of depluming				Average degree of depluming
		0	1	2	3	
		Number	Number	Number	Number	Score
C-1	Mixed grains, meat meal, no pasture	5	6	12	1	1.4
C-2	Mixed grains, meat meal, pasture	6	10	8	0	1.1
C-3	Yellow corn, skimmilk, pasture	0	4	13	7	2.1
C-4	Yellow corn, meat meal, pasture	0	1	5	17	2.7
C-5	Yellow corn, mash, pasture	19	4	0	0	0.2
C-6	Yellow corn, mash with 5% alfalfa leaf meal, no pasture	5	18	0	0	0.8

Comparison of lot C-1 with C-2 and of C-5 with C-6 shows that the birds with pasture suffered less from feather picking than those on the bare yards. On the contrary, the most severe outbreaks occurred in lots C-3 and C.4, which had pasture. Since neither of these pens received oats or wheat bran, which are fibrous feedstuffs, it is possible that lack of fiber in the diets aggravated the vice.

OBSERVATIONS ON PASTURE CROP

A mixture of crimson clover and Tennex winter oats was used as a pasture crop for all lots that received green feed. This type of pasture proved very satisfactory both winters, as it can withstand considerable grazing and low temperatures. Comparison of this pasture with winter oats pasture and with ryegrass-crimson clover pasture, which was provided the Barred Rock pullets during 1941-42 (Part 1), shows that the qualities of the oats-crimson clover pasture equal those of the ryegrass-crimson clover mixture and surpass those of oats pasture.

The Tennex winter oat seems to be especially well suited for poultry pasture. It is winter-hardy, has a deep-green color, and stools well.

SUMMARY

On the basis of results obtained in these investigations, good egg production may be expected when laying hens are fed on simple diets consisting of corn or a mixture of grains, a source of animal protein, and winter pasture. Slightly higher production may be obtained if a good laying mash, grain, and pasture are provided.

Pullets with access to afternoon grazing of winter pasture, and fed a simple ration consisting of a mixture of whole grains and meat meal, consumed as much feed as pullets fed a similar ration without pasture. However, egg production was higher and the feed cost per dozen was lower in the group with pasture.

On the basis of prices paid by the Station, feed cost per dozen eggs was slightly lower in the pen fed laying mash, grain, and pasture than in the pens fed the simpler rations with pasture.

Good hatchability was obtained in all lots provided with winter pasture and in the lot fed a laying mash containing 5 percent alfalfa leaf meal. Although mortality was low in all lots, a greater percentage of the pullets provided with pasture lived through the experiments.

Little or no difference was observed in the quality of the egg whites, regardless of the type of ration fed and whether or not pasture was available. The average yolk color of eggs from pullets with pasture was darker than that of eggs from pullets without pasture, but variation in yolk color was reduced when the layers were provided with green feed. Egg size was satisfactory in all groups.

A mixture of crimson clover and winter oats makes excellent winter pasture for the laying flock.

LITERATURE CITED

Berry, L. N. The efficiency of alfalfa leaf meal and alfalfa meal as substitutes for green feed in rations for laying hens. N. Mex. Agr. Exp. Sta. Bul. 203. 1932.

——— Ranges for the laying flock. N. Mex. Agr. Exp. Sta. Bul. 255. 1938.

Callenbach, E. W., and Murphy, R. R. Feeding systems for laying hens. Pa. Agr. Exp. Sta. Bul. 425. 1942.

Cassel, L. W. Feeding experiments with Leghorns. Wash. Agr. Exp. Sta. Bul. 210. 1927.

Davidson, J. A. The use of high-protein laying mashes. Mich. Agr. Exp. Sta. Quar. Bul. 22: 87-91. 1939.

Gish, C. L., and Payne, L. F. The importance of herbage in poultry management. Poultry Science 19: 35-41. 1940.

Graham, J. C. Individuality of pullets in balancing the ration. Poultry Science 13: 34-39. 1934.

Heiman, Victor, and Carver, J. S. The yolk color index. U. S. Egg and Poultry Mag. 41: 40-41. 1935.

——— The albumen index as a physical measurement of observed egg quality. Poultry Science 15:141-148. 1936.

Kennard, D. C., and Chamberlin, V. D. Shall the layers be ranged or confined? Ohio Agr. Ex. Sta. Bimo. Bul. 171: 193-198. 1934.

Martin, J. H. Sources of animal protein for laying hens. Ky. Agr. Exp. Sta. Bul. 260. 1925.

Ringrose, R. C., and Morgan, C. L. A study of the effect of green feed upon interior egg quality. Poultry Science 18: 125-128. 1939.

Robertson, E. I., Carver, J. S., and Cook, J. W. Methods of feeding laying hens. Wash. Agr. Exp. Sta. Bul. 381. 1939.

Sipe, G. R., and Polk, H. D. Japanese tendergreen mustard, Italian ryegrass, and oats as a source of green feed for laying hens. Poultry Science 20: 406-412. 1941.

Tomhave, A. E., and Mumford, C. W. Self selection of feeds by hens. Del. Agr. Exp. Sta. Bul. 174. 1931.

Note.—For information on culture of pasture crops, see Tenn. Agr. Exp. Sta. Bulletin 165, on "Clovers and Grasses for Hay and Pasture", by C. A. Mooers, which can be obtained upon request.